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ABSTRACT

Frozen 3:1 and 4:1 whole goat's milk concentrates were stored at −14°C for up to 10 months with minimal changes in physical stability and no loss of flavor quality when reconstituted. The processing sequence required HTST pasteurization, lactose hydrolysis by lactase enzyme (36% hydrolysis for 3:1 concentrates and 52% hydrolysis for 4:1 concentrates), repasteurization, condensing in vacuo, post heating at 71°C for 30 min, addition of Tenox 6 (0.01g/100g fat), canning, sealing, and freezing. Post heating of the concentrates was necessary for their stability but slightly lowered their hedonic flavor ratings. These stored concentrates resist freeze-thaw cycling up to 3 times without any physical destabilization or further change in flavor scores.

INTRODUCTION

GOAT MILK is consumed primarily by infants or children who are allergic to cow's milk. Because the milk is usually distributed in small amounts, it incurs high transportation and handling costs. Consequently, fresh goat milk is frequently sold at a price three to four times higher than the price of cow's milk.

Considerable amounts of goat milk sold commercially are of poor flavor quality. The presence of so-called "goaty" flavor in the milk has been a barrier to more wide-spread use by consumers in the United States. Our investigations with goat milk showed it to be of good flavor quality if properly handled and obtained fresh.

The availability of goat milk is highly seasonal; much more is produced during the summer months than in the late fall and winter. To increase its distribution and make goat milk available throughout the year, it would be desirable to process the surplus and distribute it throughout the country. It was thought that frozen concentrates would permit distributon for sale in freezer cases of health food stores, drugstores, or supermarkets. Processing and distribution costs could be offset in part by savings from the reduced bulk and the potential demand for good quality goat's milk concentrates.

The objective of the present work was to investigate the factors of processing, concentrating, freezing, and storing of goat's milk which would produce a concentrate of good storage stability and of acceptable flavor when reconstituted.

No information is available on frozen condensed goat's milk, but numerous publications are available on frozen condensed cow's milk. Several problems are associated with frozen concentrated cow's milk. It lacks stability at home freezer temperatures (−12 to −14°C) due to lactose crystallization which causes an increase in viscosity and protein destabilization. Oxidized flavors may also develop in the stored product. Physical stability can be improved by storing at lower temperatures (−23 to −29°C) (Bell and Mucha, 1952), by post heating the concentrate to 68°C for 25 min (Bratz and Winder, 1959), partially hydrolyzing the lactose (Guy et al., 1974; Turmerman et al., 1954), and by addition of polyphosphates (Doan and Warren, 1947). Oxidized flavor is minimized by judicious use of heat treatment (Bell, 1939; Bell and Mucha, 1951) and use of Tenox 6 (Johnson, 1970). Johnson stated studies on the effect of various freezing rates and handling of milk concentrates have produced conflicting results probably because the influence of lactose nucleation and crystallization on protein stability were not recognized. He recommends cooling milk concentrates in an ice water bath for 30 min at 0°C prior to freezing at −12°C in 2–3 hr.

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MATERIALS & METHODS

Milk

Fresh pooled goat's milk was obtained from a single source of mixed breed herd. All milk scored good to excellent in initial taste and exhibited minimal goaty flavor.

Miscellaneous materials

Food grade "Maxilact" lactase (Enzyme Development Co.) of 40,000 ONPG μ/g (lot #101) (actual 18,000 ONPG μ/g) was used. Eastman Tenox 6 antioxidant preparation and JT Baker sodium hexametaphosphate (P_2O_5 66.8–68%) were also used.

Processing

Fresh raw goat milk was pasteurized at 76°C for 15 sec (HTST); one lot was pasteurized at 63°C for 30 min. All lots except a portion of lot 1 were homogenized at 105.5/35.2 kg/cm^2. Milks were treated with 0.01–0.0175% lactase at 30°C for 2 hr to hydrolyze 36% or 52% of the lactose present. Hydrolyzed lactose milks (LH) were promptly HTST pasteurized to stop the enzymatic reaction. 3:1 or 4:1 concentrates were prepared by condensing in a Wiegand falling film evaporator. For one test evaluating sodium hexametaphosphate, 4g/L were added to the concentrate before post heating. The concentrates were post heated in open 1-gal stainless steel containers at 63, 66 or 71°C for 30 min. To obtain 26% LH concentrates, 50/50 blends of 52% LH and an untreated control were made up. Tenox 6 (0.01 g/100g fat) in a 10% suspension of 95% ethanol was added to the concentrates after post heating. The concentrates were sealed in enameled 8 oz cans at 45–50°C, the cans promptly cooled for 30 min in ice water and then frozen by holding in spaced positions at −14°C.

Milk Composition

Total protein (total N X 6.38) was determined by the micro-Kjeldahl procedure (AOAC, 1970b), ash by the standard method for milk (AOAC, 1970a), and total solids and fat by the Mojonnier procedures (Milk Industry Foundation, 1959a, b). Lactose was determined colorimetrically in untreated milk (Folin and Wu, 1919), by reduction of copper salts in alkaline Fehling's solution using USP lactose hydrate for the standard curve.

Extent of hydrolysis

The Tauber Kleiner method (Tauber and Kleiner, 1932) based upon the reduction of copper salts in acid solution was used to determine monosaccharides in the presence of lactose. A standard curve was made with a 50/50 mixture of glucose and galactose.

Viscosity

Viscosities were determined on freshly thawed concentrates at 23°C using the Brookfield Synchroelectric Viscosimeter. Viscosities

of samples below 100 centipoise were obtained using the mean of duplicate readings each at 12 and 30 rpm with the UL adapter and #1 spindle. Viscosities above 100 centipoises were obtained employing higher numbered spindles. Comparative viscosities were obtained within a sample series using the same spindle and rpm as much as possible.

Lactose crystallization

The fraction of lactose crystallized was determined on weighed portions of frozen milk concentrate according to the technique of Tumerman et al. (1954) using the Sharp and Doob (1941) procedure. Samples weighing 10g were placed in 200 ml beakers, held frozen at −14°C and analyzed within 8 hr for extent of lactose crystallization.

Sedimentation

Solubility indices were determined on 11% total solids milks reconstituted from their concentrates (ADMI 1947) and are expressed as milliliters sediment per 50 ml reconstituted milk.

Organoleptic evaluation

Samples of freshly thawed concentrate were reconstituted with tap water, held overnight at 2°C, warmed to room temperature, and evaluated on a 9-point hedonic preference scale (Peryam and Pilgrim, 1957) in a panel room equipped with subdued lighting and individual booths by a group of 8–12 laboratory personnel. About half of the tasters were experienced dairy product judges. Goatiness and off flavors were judged on a 5-point scale, with 0 as none, 1 questionable, 2 slight, 3 moderate, and 4 excessive. (Note: Goatiness can be described as typical goat-like taste and smell of goat's milk which is generally objectionable. Some describe it as mutton-like or buck-like.) Samples were withdrawn from storage for evaluation at intervals of 1, 1.5, or 2 months over a 10-month period. Upon completion of each panel, the 9-point hedonic data were analyzed for significance by analysis of variance and Duncan's multiple range test.

Freeze-thawing

To simulate abuse in transit, storage, or home use, samples of concentrate were thawed in unopened cans 2–2½ hr at room temperature to the point of being ice-free but yet cold. They were then refrozen at −14°C. Thawings were conducted at weekly intervals during the first month of storage.

Table 1—Composition of goat's milk

Lot no.	Percent				
	Total solids	fat	Lactose	Protein	Ash
1	14.76	5.31	4.12	3.98	.79
2	12.00	3.50	4.26	3.18	.71
3	10.91	3.00	4.20	2.66	.64
4	13.00	4.28	4.32	–	–

RESULTS

THE TOTAL SOLIDS, fat, protein, and ash content of goat's milks vary considerably, although the lactose content is more constant (Table 1). A 3:1 concentrate of Lot No. 1 had 42.5% total solids, higher than the ususal range of 33–36%.

To determine the effect of the temperature of post heating on the physical stability of a 3:1 concentrate during storage, samples of the same lot (lot 2) were post heated at 63, 66, or 71°C and compared to an unheated control. The rates of lactose crystallization, viscosity increase, and protein sedimentation during 4.5 months of storage were progressively decreased as the temperature of post heating increased to 71°C (Table 2). Because physical stability in terms of these three parameters was best at 71°C, this temperature was used for post heating in all subsequent processing runs.

The intensity of goaty flavor in all post heated samples was increased over that of the unheated controls (Table 2). However, there were no significant differences in goaty flavor intensity attributable to post heating temperatures or storage times.

As little as 26% lactose hydrolysis of goat's milk improved the physical stability of its frozen 3:1 concentrates (42.5% total solids) (Table 3). With lactase-treated concentrates, post heating was not necessary to prevent lactose or sugar crystallization and extensive sedimentation during the storage period, but was necessary to prevent viscosity increases in the stored material. Post heating delayed, but did not prevent, lactose crystallization and protein sedimentation of the stored control. The viscositites of the concentrates of the unheated control and hydrolyzed lactose concentrates were high and comparable but the consistencies of the high viscosity samples were different; those of the hydrolyzed concentrates were smooth whereas that of the control was lumpy and coagulated. Extensive fat separation was also observed upon reconstitution of the unheated samples after 6 or more months of frozen storage, probably because these samples were not homogenized.

Lactose hydrolysis confers stability on a 4:1 frozen concentrate (Table 4). While 26% lactose hydrolysis was not sufficient to stabilize the concentrate completely because lactose crystallized out after 4 months of storage, 52% hydrolysis prevented crystallization for up to 10 months. Viscosity slowly increased in both sample sets over the storage period; viscosities were higher in the sample containing 26% hydrolyzed lactose. No unhydrolyzed 4:1 control concentrate was prepared because post heated 3:1 control concentrates showed sharp viscosity increases after only 3 months of storage (Table 3). Although higher for the 26% lactose hydrolysis, the sedimentation in both sample sets did not vary much over the storage period.

Although post heating of the goat milk concentrates promoted physical stability, it also appeared to promote goaty flavor development (Table 2). To investigate this

Table 2—Effect of post heating temperature of a 3:1 goat's milk concentrate (Lot 2) on storage stability at −14°C (Samples pasteurized at 63°C 30 min, homogenized at 105.5/35.2 kg/cm², post heated 30 min)

Months storage	Post heating for 30 min in °C															
	% Lactose crystallized				Centipoise viscosity at 23°C				Milliliters sedimentation				Goatiness score			
	Unheated	63	66	71	Unheated	63	66	71	Unheated	63	66	71	Unheated	63	66	71
0	0	–	–	–	10.8	10.8	12	12.5	0.1	–	–	–	1.4	1.7	2.6	2.7
1.5	54	0	0	0	14.2	11.7	11.9	12.8	0.1	0.2	0.1	0.1	1.5	1.7	2.1	1.8
3.0	81.5	27.5	20	0	87.4	13.9	14.6	13.0	3.5	0.7	0.5	0.5	1.8	2.4	2.7	2.5
4.5	90.0	75.5	73.5	64	1375[a]	44	39	30	4.5	0.9	0.8	0.6	1.5	2.4	2.7	1.6

[a] coagulated.

Table 3—Effect of partial lactose hydrolysis (LH) and post heating at 71° C for 30 min on storage stability at −14° C of 3:1 goat milk concentrates compared to an unhydrolyzed control concentrate (c) (lot 1) (unheated samples not homogenized; heated samples homogenized 105.5/35.2 kg/cm²)

	% Lactose crystallized				Viscosity 23°C (centipoise)						Milliliters sedimentation					
	Unheated		Post heated		Unheated			Post heated			Unheated			Post heated		
Months storage	C	26% LH and 52% LH	C	26% LH and 52% LH	C	26% LH	52% LH	C	26% LH	52% LH	C	26% LH	52% LH	C	26% LH	52% LH
0	0	—	—	—	27	30	30	93	—	83	0.1	—	—	—	—	—
1.5	—	—	—	—	136	98	192	101	105	110	—	—	—	—	—	—
3.0	70.4	0	3.5	0	21[a]	24.8[a]	26.8[a]	395	130	115	5.0	0.1	0.1	0.1	0.1	0.1
4.5	83.5	0	4.0	0	24[a]	20[a]	50[a]	865	172	150	8.0	0.4	0.5	2.2	0.1	0.1
6.0	—	0	73.5	0	—	27[a]	45[a]	16[a]	220	165	—	0.4	0.5	4.5	0.2	0.2
7.5	—	0	—	0	—	21.5[a]	54.5[a]	28[a]	231	178	—	0.3	0.4	6.0	0.3	0.3

[a] ×10³

observation further, samples from each stage of processing of an untreated control and a lactase treated 3:1 concentrate were evaluated for overall acceptability and for goaty and oxidized and bitter off-flavors (Table 5). Nubian goats milk, obtained fresh from one supplier, was used in these studies because its mild flavor makes it suitable to evaluate the effects of heat on flavor development. Because of taste panel limitations, it was not possible to taste all samples on the same day.

The post heating of goat milk concentrates significantly lowered the initial hedonic rating three out of four times. Although not significantly different, post heating also increased goaty and oxidized and bitter off-flavors. The post heating temperature of 71°C was evidently not severe enough to produce any noticeable increase in cooked flavor. The concentration step had no significant effect on panel acceptability of the milks and the results suggest that lactase treatment did not change acceptability. It is important to note that in spite of the decrease in hedonic ratings brought about by post heating, the scores still fell within the acceptable range of the rating scale used.

Because it was known that the development of oxidized off-flavors in frozen cow's milk concentrates could be minimized by addition of antioxidants (Johnson, 1970), Tenox 6, a common antioxidant, was tested for its effect on the flavor stability of 3:1 and 4:1 goat milk concentrates during storage.

Tenox 6, added at a level of 0.01g/100g fat, maintained the hedonic flavor ratings of stable 3:1 condensed 26% lactose hydrolyzed goat milk concentrates after 4 months storage, while those of the untreated controls declined somewhat and leveled off (Fig. 1). The Tenox 6 treated concentrates also had lower levels of oxidized and bitter flavors than those of the untreated concentrates. Overall goatiness of the concentrates remained relatively constant with time.

The 4:1 lactase treated concentrates with Tenox 6 also had higher hedonic ratings when reconstituted and contained less oxidized and bitter flavors than those of their controls after 4 months storage and were similar in goatiness.

Since the differences in hedonic ratings between the control and antioxidant treated samples were not as marked in most instances as with the 3:1 concentrates, the data are not shown. The degree of lactose hydrolysis (26 or 52%) did not affect acceptability. Also flavor scores for reconstituted unhydrolyzed 3:1 concentrates stored up to 4 months paralleled those of both the hydrolyzed 3:1 and 4:1 concentrates that did not contain added antioxidants during the early stages of storage. The unhydrolyzed samples thickened and coagulated as storage time progressed so they were not tasted.

Table 4—Effect of partial lactose hydrolysis (LH) on storage stability at −14° C of 4:1 (48% total solids) goat milk concentrates (Lot 4) (Samples homogenized 105.5/35.2 kg/cm², post heated at 71° C 30 min)

	% Lactose crystallized		Viscosity 23°C (centipoise)		Milliliters sedimentation	
Months storage	26% LH	52% LH	26% LH	52% LH	26% LH	52% LH
0	0	0	274	215	—	—
2	0	0	295	225	0.2	<0.1
4	0	0	320	280	0.6	<0.1
6	9.5	0	480	358	0.4	<0.1
8	32.6	0	710	365	0.5	<0.1
10	33.0	0	2200	480	0.6	0.1

Abuse of frozen products once they have been shipped by the manufacturer is becoming increasingly common. Therefore, the effects of freeze-thaw cycling on the physical stability of 3:1 (35% total solids) frozen goat milk concentrates were determined. Abusing 3:1 control concentrates by thawing and refreezing up to three times resulted in accelerated destabilization after total elapsed storage times of 1.5 and 3 months (Table 6). As the samples were repeatedly thawed and refrozen, viscosity, lactose crystallization, and sedimentation all increased. After 3 months of storage, freeze-thawing even once completely destabilized the stored concentrate.

When 3:1 concentrates with 26% hydrolyzed lactose were abused by freezing and thawing (FT) three times, viscosity and "apparent" lactose crystallization increased slightly after only 2 months of storage and rapidly after 4 months (Fig. 2). However, 36% and 52% lactose hydrolysis, respectively, stabilized their 3:1 and 4:1 concentrates against three freeze-thaw abuse cycles. These samples stored up to 10 months showed only small viscosity increases and no lactose crystallization and maintained sedimentation values of 0.1 cc or less. Viscosities of 36% lactose hydrolyzed 3:1 concentrates increased from 10.9 and 15.2 centipoises; FT cencentrate viscosity increased to 16.8 centipoises. Viscosities of 52% lactose hydrolyzed 4:1 concentrates increased from 225 to 395 centipoises; those of the FT concentrates increased to 590 centipoises.

FT of both 3:1 and 4:1 stored frozen concentrates had no statistically significant effect on the overall panel acceptability of their reconstituted milks (Table 7), but in seven out of eight trials, hedonic scores of these samples were at least equal to or slightly higher than their controls. However, the effects of FT on oxidized and bitter as well as goaty scores were not consistently different.

Polyphosphates are frequently added to concentrated milks to prevent thickening and coagulation on storage.

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Table 5—Effect of processing steps in hedonic rating and goaty and oxidized off-flavor development during 3:1 concentrate processing

Sample	Hedonic rating[a] 9-Point scale		Goatiness 5-Point scale		Oxidized and bitter 5-Point scale	
	Fresh	day old	Fresh	day old	Fresh	day old
Raw	6.55[bc]	–	0.55	–	0.11	–
		Control				
Pasteurized 77°C 15 sec Homogenized 105.5/35.2 kg/cm²	6.88[c]	6.50[bc]	0.44	0.80	0.33	0
Condensed 3:1 Reconstituted to 11.8% total solids	6.55[bc]	–	0.67	–	0.33	–
Condensed 3:1 Post heated 71°C 30 min Reconstituted	5.44[b]	6.40[bc]	1.22	0.80	0.55	0.20
	Lactose treated (LH) –33% hydrolyzed lactose					
Pasteurized, Homogenized LH	–	7.20[c]	–	0.50	–	0.20
LH condensed 3:1 Reconstituted	–	7.20[c]	–	0.50	–	0.20
LH condensed 3:1 Post heated Reconstituted	5.44[b]	5.80[b]	1.33	1.10	0.22	0.60

[a] 5.0 Neither like nor dislike; 6.0 Like slightly; 7.0 Like moderately.
[b,c] Means in the same line bearing different superscript letters differ, $p < 0.05$.

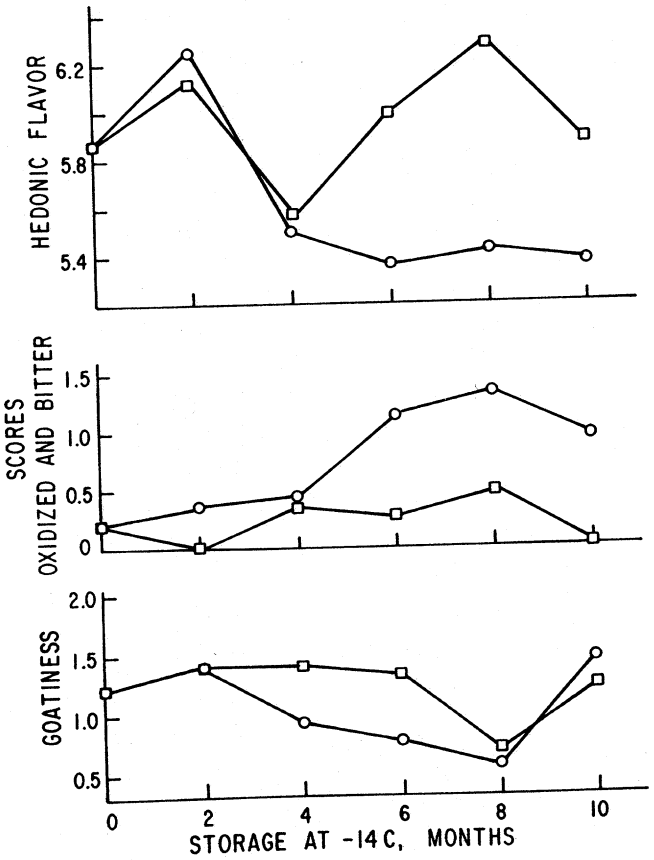

Fig. 1—Effect of Tenox 6 on the flavor scores of milks reconstituted from 3:1 (36% solids) hydrolyzed lactose (LH) goat milk concentrates: 0——0 26% LH untreated; □——□ 26% LH with Tenox 6 (0.01 g/100g fat) (Lot 4).

Table 6—Effect of repeated thawing of 3:1 (35% total solids) concentrates (Lot 3) 2 hr at 23° C, then refreezing and storing at −14° C on physical stability

Age in weeks when thawed	Viscosity at 23°C (centipoise)	% Lactose crystallized	Milliliters sedimentation
	Stored 1.5 months		
(Not thawed)	12	0	0.1
1	412	69.5	0.1
1, 2	750	91.5	0.2
1, 2, 4	1,400	101.0	1.0
	Stored 3 months		
(Not thawed)	24	7.1	7.7
1	725	90.5	10.0

Addition of 0.4% sodium hexametaphosphate to milks not treated with lactase resulted in concentrates of increased physical stability (although they contained high levels of crystallized lactose) but of poor flavor quality on extended storage (Table 8). Because the addition of sodium hexametaphosphate to goat milk concentrates lowered hedonic ratings and increased oxidized and bitter flavors, its use is not recommended even though physical stability was enhanced.

DISCUSSION

AVAILABILITY of fresh goat milk to the consumer is highly seasonal and often limited. Therefore, an important step in market expansion and development of new markets for goat milk is to preserve the milk for distribution year round. Freezing has always been considered to be a desirable way of preserving cow's milk because minimal flavor changes are caused by the freezing process.

In the work reported here, it has been demonstrated that 3:1 and 4:1 concentrates of whole goat's milk may be stored frozen for up to 10 months with minimal changes in

physical stability provided the lactose is sufficiently hydrolyzed and the concentrates are post heated before canning. Although it was observed that stored lactase treated 3:1 concentrates (not post heated and not homogenized) showed marked viscosity increases over the storage period (Table 3), no significant sedimentation and "apparent" lactose crystallization took place. These results were in contrast to those reported for cow's milk (Guy, 1974) where heavy coagulation occurred in concentrates containing 89% hydrolyzed lactose. The cow's milk samples had been homogenized but not post heated.

The values of crystallized lactose reported in samples containing partially hydrolyzed lactose should be considered only as "apparent" values. The analytical procedure used to measure crystalline lactose is a polarimetric one (Sharp and Doob, 1941); the glucose and galactose present in the samples as a result of lactose hydrolysis could also crystallize out during storage and contribute to the changes in optical rotation measured.

Bitter and oxidized flavor scores were added together because they constituted the main criticisms of the milk which could adversely affect flavor. Also average scores of oxidized and bitter flavor may be slightly low because several members of the taste panel had difficulty detecting them or describing them due to their inexperience and presence of other flavors. Because the total number of panelists was limited, in part due to adverse bias against the product, rigid panel selection was not practical. Several members, however, were experienced dairy product judges. For these reasons and the limitation of time and samples for repeat testing, no attempt was made to analyze statistically these scores. However, because Tenox 6 antioxidant consistently lowered oxidized and bitter scores in concentrates stored beyond 4 months, it was believed the average scores were a meaningful indication of differences. With the exception of one or two panelists, goaty flavor was consistently detected and scored by the panel. Although these scores were statistically analyzed, because of the range of scores obtained and limited panel members, no significant differences in scores were obtained for any one testing.

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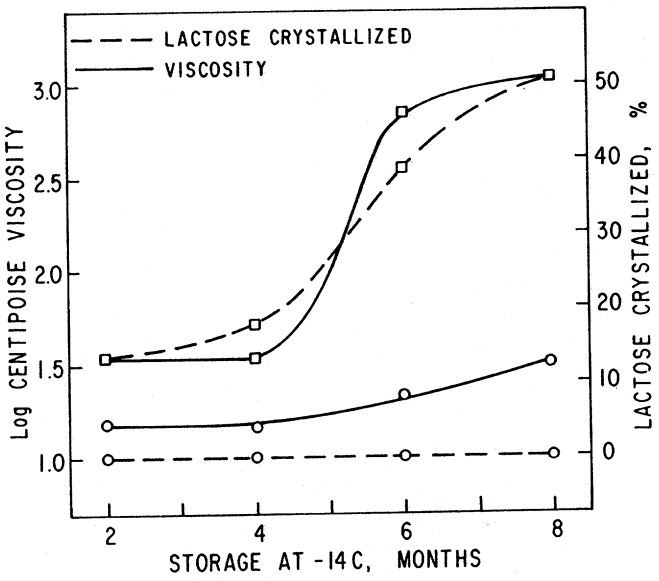

Fig. 2—Effect of storage time on the viscosity and lactose crystallization of goat milk concentrates subjected to freeze-thaw abuse (3X): O——O 3:1, (36% total solids), 26% hydrolyzed lactose (LH); □——□ freeze-thawed 26% LH.

Table 7—Effect of freeze-thawing (FT) on the panel acceptability of goat milk reconstituted from frozen lactose hydrolyzed (LH) 3:1 and 4:1 concentrates stored at −14° C

Concentrate	Months storage	9-Point hedonic score
3:1 26% LH		
Control	6	5.37
FT-3X	6	5.75
Control	8	5.42
FT-3X	8	5.42
3:1 36% LH[a]		
Control	7.5	4.62
FT-3X	7.5	5.37
Control	9	4.70
FT-3X	9	5.30
4:1 26% LH		
Control (T-6)[b]	6	5.55
FT-1X	6	5.90
Control	8	6.28
FT-1X	8	6.28
4:1 52% LH		
Control	8	5.73
FT-3X	8	5.87
Control (T-6)	10	6.75
FT-2X	10	6.20

[a] Lot 3; remainder lot 4
[b] T-6 = Tenox 6, 0.01 g/100 g fat

Table 8—Effect of 0.4% sodium hexametaphosphate (NaHP) on the storage characteristics of 3:1 concentrated goat's milk (Lot 4)

Months storage	Viscosity at 23°C (centipoise)		% Lactose crystallized		Milliliters sedimentation		9 Point hedonic score		Oxidized and bitter		Goatiness	
	Control	NaHP	Control	NaHP	Control	NaHP	Control	NaHP	Control	NaHP	Control	NaHP
0	18.8	22.6	0	0	—		6.25	5.86	0.11	0.55	1.56	1.77
2	145	28	57	0	0.4	0.2	5.42	5.85	0.12	0.62	1.6	1.6
4	318	200	51.5	71	2.5	<0.1	5.33	4.58	0.41	0.75	1.5	1.6
6	1720[a]	257	89	81	10	<0.1	5.85	4.42	0.85	0.85	1.1	1.4
8	2100[a]	435	95	79.5	11.5	0.1	4.25	4.12	0.66	1.86	0.44	1.00
10	—	688	—	86	—	0.1	—	3.50	—	1.89	—	0.75

An intermediate level of Tenox 6, (0.005g/100g fat), was also tested in some concentrates. Hedonic flavor ratings were found to be intermediate between those received by reconstituted samples containing 0.01% antioxidant and their controls. It might be noted that the effect of antioxidant is important in samples stored beyond 4 months' time; omission of it had no effect on hedonic ratings of concentrates stored for short periods of time. The overall data agree in showing that the concentrates containing Tenox 6 (0.01g/100g fat) stored beyond 4 month's time consistently received higher flavor ratings than the untreated controls.

Sweetness of 26 and 52% hydrolyzed lactose reconstituted concentrates was oftentimes detected by panelists but did not significantly alter the hedonic panel scores from those of the unhydrolyzed controls. This is in agreement with the findings that 30–60% lactose hydrolysis of cow's milk does not significantly affect the hedonic panel scores. Above 60% hydrolysis, cow's milk received a lower panel rating (Guy et al., 1974).

CONCLUSIONS

THE OVERALL RESULTS of the study show the processing conditions which stabilize cow's milk concentrates during frozen storage also are useful for goat's milk. In addition, repeated thawing and refreezing may even increase the flavor scores of frozen goat's milk concentrates when part of the lactose present has been hydrolyzed.

Commercial adoption of the processing sequence [HTST pasteurization, partial lactose hydrolysis with lactose enzyme (36% hydrolysis for 3:1 concentrates and 52% hydrolysis for 4:1 concentrates), repasteurization, condensing in vacuo, post heating the concentrate at 71°C for 30 min, addition of Tenox 6 (0.01g/100g fat), canning, sealing, and freezing] can help ensure a year round supply of acceptable whole goat's milk to the consumer, thereby improving economic benefits to the dairy goat farmer. Reduction of lactose content of goat's milk by treatment with lactase enzyme could provide an additional benefit to those consumers who are ot only allergic to cow's milk protein but are also lactose intolerant.

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Ms received 7/3/81; revised 9/11/81; accepted 9/15/81.

The author expresses his sincere thanks to P.W. Smith and S. Quillens for assistance in sample processing and to F.B. Talley for taste panel services.

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